Two heavy rains crossed the state during the first week, and a third on the 8th and 9th ushered in a week of clear weather. The northern section had light rains on the 17th, 18th, 19th; and on the 20th another general storm occurred, giving a moderate rainfall from the 20th to the 23d, when the month was finished with fair weather.

Summary.

Mean temperature, 71°.0; highest temperature, 102°.0, on the 20th, at Pomeroy; lowest temperature, 38°.0, on the 24th, at Paulding; range of temperature, 64°.0; mean daily range of temperature, 22°.6; greatest daily range of temperature, 45°.0, on the 27th, at Paulding; least daily range of temperature, 2°.5, on the 10th, at Napoleon.

Average number of clear days, 14.0; average number of fair days, 10.0; average number of cloudy days, 6.0; average number of days on which rain fell, 9.7.

Greatest number of days on which rain fell, 15, at Cleveland; least number of days on which rain fell, 6, at North Lewisburg and Sydney.

Mean monthly rainfall, 3.85 inches; average daily rainfall, .128 inch; average monthly rainfall for northern section, 4.21 inches; average monthly rainfall for middle section, 3.92 inches; average monthly rainfall for southern section, 3.40 inches; greatest rainfall, 6.67 inches, at Hudson; least rainfall, 1.69 inches, at Washington Court House.

Prevailing direction of wind, southwest.

"Oregon Weather Service," report prepared by B. S. Pague, Private, Signal Corps:

Temperature.—The temperature was below the normal throughout the state, especially along the coast. A warm wave extended over the state on the 22d, except in the southeastern counties, where it was felt on the 22d. Ashland reports the highest temperature, 103°. It was generally cool during the first half of the month, the lowest reported was 24°, on the 5th, at Linkville.

Rainfall.—The rainfall has been below the average in all parts of the state, except in the northeastern counties where it was slightly above the average. The most marked departure was at Astoria, where it was 1.15 inches below the average, and at Bandon, where it was 1.01 below the average. The seasonal rainfall has been above the average along the coast and interior valleys, except in Portland, where it was nearly normal, and below the average in the southern part of the state. The greatest excess was at Astoria, where it amounted to 15.27 inches. The greatest deficiency was at Lakeview, where it amounted to 4.37 inches. Rain fell on ten days at Portland, and on a less number of days at the other stations, the least number of days being at Bandon, where it fell on only three days.

Weather.—No general storm appeared during the month; the rainfall was in showers, and the prevailing weather was clear.

Winds.—The winds were generally northerly, except at Astoria where they were southwesterly, and at Lakeview where they were southerly. They were generally fresh, rather above the average in force.

Lakeview reports frost on the 6th, snow (in small quantities) on the 5th and 11th, and a thunder-storm on the 22d.

The "South Carolina Weather Service," Hon. A. P. Butler, Commissioner of Agriculture for South Carolina, director:

The noteworthy features of this month have been: 1st. The cool weather which occurred from the 12th to 14th. 2d. The unusually high temperature of the 19th and 20th; and 3d. The period of dry weather, which, with the exception of light local showers on the 10th and 11th, prevailed in all sections of the state from the 3d until the 20th.

A warm wave occupied the state on the 9th and 10th, and during those dates the maximum temperature at several stations reached or exceeded 100°. On the 9th the maxima were as follows: Chester, 103°; Blackville, 102°; Jacksonborough, 100°; Saint George's, 100°; Bennettsville, 99°; Brewer Mines, 98°. On the 10th they were: Saint Matthew's, 102°; Hampton, 101°; Jacksonborough, 100°; Saint George's, 100°; Winnsborough, 99°; Bennettsville, 99°; Chester, 99°; Allendale, 99°; Yemassee, 98°.

During the hot wave of the 18th to 20th the maximum temperature at many of the stations reached 100° on three successive days.

The mean temperature for the month has been, notwithstanding the high maxima for the three days referred to above, slightly below the normal. At Charleston the mean temperature was 77°.4, or about 2° below the mean for the last sixteen years. In the central and upper counties the difference is slight.

The rainfall has been less than the average in all sections of the state. At Charleston it was 4.54 inches, which is 1.12 inches less than the average rainfall for June, as determined from records of the past sixteen years.

The month as a whole has been favorable to farming operations. The absence of rain enabled farmers to harvest successfully the small grain crops. Corn began to suffer for rain, but the abundant and timely showers which occurred during the last decade of the month prevented any serious damage.

Summary.

Mean temperature, 77°.9; highest temperature, 107°, at Bennettsville and Hampton, on the 20th; lowest temperature, 44°, at Kingston, on the 13th; range of temperature, 63°; greatest daily range of temperature, 47°, at Spartanburg and Hampton, on the 14th; least daily range of temperature, 6°, at Brewer Mines, on the 11th, and at Charleston on the 26th.

Mean depth of rainfall, 3.53 inches; greatest monthly rainfall, 5.72 inches, at Newberry; least monthly rainfall, 1.13 inches, at Bennettsville; greatest daily rainfall, 3.12 inches, at Winnsborough, on the 23d; least daily rainfall, trace (amount inappreciable), at Charleston on the 2d, and at Columbia on the 19th, 21st, and 27th. Average number of rainy days, 8.1.

Copious rains occurred in the upper and middle counties on the 1st and 2d, and from the 20th to the 23d. In the lower counties the heaviest rains of the month occurred during the period from the 25th to 27th, inclusive.

The following is an extract from the report of the "Meteorological Department of the State (Tennessee) Board of Health," prepared under direction of J. D. Plunkett, M. D., President of the State Board of Health, by H. C. Bate, Signal Corps, Assistant, Nashville:

The special meteorological features for the month of June were the high temperature about the 19th and 20th, the severe local hail storms, the abnormally small amount of precipitation, and the small percentage of cloudiness.

The mean temperature was 73°.4, the highest for the past five years, except in 1885, when it was 74°.6. The highest temperature reported was 100°.0 on the 19th and 20th, and was 2°.0 above the record of the five preceding years. The lowest was 45°.0, recorded on the 25th, although from most of the stations in the state the minimum was recorded on the 1st and 2d. This was the lowest reported during the past five years. It was reported from the Cumberland plateau, one of the most elevated stations in the state. The range of temperature was several degrees more than that previously reported.

The mean rainfall was 2.77 inches, by far the smallest amount for June in many years. It was about an inch and a half less than in 1885, and four and one-half inches less than the mean for June of last year, which was abnormally great. At many places in the state the rainfall was the least recorded in many years. At Memphis and Nashville it was the least June rainfall since the establishment of the Signal Service observations in 1871, and at Chattanooga it was the least since 1879. Of the amount the eastern division received an average of a little more than two and a half inches, the middle division about three inches, and the western division about two and a half inches. The rains were, for the most part, light and local in their character and badly distributed, only a few being general, notably those of the 1st, 3d, 6th, and 21st. During the first decade rains were frequent, but during the second decade there was scarcely any rain in the state, a few stations in the central part reporting light showers, and most of them inappreciable. The greatest rainfall was 5.30 inches, reported at Savannah, and the least was only 1.04 inches, reported at Memphis, about one hundred miles distant. The greatest local daily rainfall was 2.60 inches, reported on the 21st at Manchester. Perhaps the heaviest local rain of the month was at Lynnville, Giles Co., on the 19th. The days of the greatest rainfall were the 1st, 3d, 6th, and 21st, and of these the greatest was on the 1st. There were eight days on which no rain was reported in the state. While the drought during the second decade of the month was somewhat injurious to the growing crops, it was very favorable for the wheat and hay harvest, which progressed most favorably, and much was added to the yield, especially of the latter.

Summary.

Mean temperature, 73°.4; highest temperature, 100°.0, on the 19th, at Cookeville, and on the 20th, at Austin; lowest temperature, 45°, on the 25th, at Farmingdale; range of temperature, 55°.0; mean monthly range of temperature, 42°.5; greatest monthly range of temperature, 52°.0, at Hohenwald; least monthly range of temperature, 30°.0, at Covington; mean daily range of temperature, 18°.5; greatest daily range of temperature, 38°.0, on the 14th, at Farmingdale, and on the 20th, at Hohenwald; least daily range of temperature, 3°.0, on the 1st, at Florence Station; on the 3d, at Ashwood; on the 11th at Covington, and on the 28th, at Beech Grove; mean of maximum temperatures, 95°.8; mean of minimum temperatures, 53°.3.

Average number of clear days, 13.8; average number of fair days, 10.5; average number of cloudy days, 5.7; average number of days on which rain fell, 8.6.

Mean depth of rainfall, 2.77 inches; mean daily rainfall, 0.092 inch; greatest rainfall, 5.30 inches, at Savannah; least rainfall, 1.04 inches, at Memphis; greatest local daily rainfall, 2.60 inches, on the 21st, at Manchester.

Days of greatest rainfall, 1st, 3d, 6th, 21st; day of greatest rainfall, 1st; days without rainfall, 12th, 13th, 14th, 15th, 16th, 17th, 23d, 24th.

Warmest days, 19th, 20th; coldest days, 1st, 2d.

Prevailing winds, westerly.

NOTES AND EXTRACTS.

OCEAN FOG PREDICTIONS.

[By Sergeant E. B. GARRIOTT, Signal Corps.]

In articles in the MONTHLY WEATHER REVIEW relative to this subject it was shown that the fog of the Banks of Newfoundland was caused by warm air from over the Gulf Stream blowing over the cold surface of the ice-fields and Arctic currents; it was also shown that the cyclonic areas which passed over and from the North American continent were the agents whereby the intermingling of these masses of warm and cold air was effected.

In treating of the fog which developes over the ocean west of the sixtieth meridian and north of the thirty-fifth parallel, it will be necessary to consider, not only the influence of the ocean currents, but also the air which is blown from over the land. With the fact ever prominent that the intermingling of warm, humid air and cold or chilled air is necessary to fog development, it remains to determine how this contact may be brought about.

In the case of Newfoundland fogs it appeared that the ocean currents and ice-fields afforded the means whereby the air overlying them was warmed or chilled. In the vicinity of the coast in more southern latitudes the ocean currents still continue important agents in the development of fog. The Gulf Stream flows about northeast from the thirty-fifth parallel, and the normal condition of the air overlying its surface is warm and moist. To the westward of this warm current, and closely following the coast, a cold ocean current flows southwestward. The differences in temperature of air overlying these currents are not, ordinarily, sufficiently great to cause fog precipitation, and abnormal conditions are, therefore, required for its development. These conditions would exist with the contact between warm, moist air blown from over the Gulf Stream and cold air from over the continent, and to develope them it would be necessary to have a continued flow of air from the ocean, attending the wind circulation in the eastern quadrants of a low barometer area, intermingle with the cold air from over the land to the northward following its passage. The element of warm, moist air would thus be collected within the eastern half of a cyclonic area and the cold air would flow southward west of the storm-centre, the point of contact being in the southern quadrants. Under these conditions the development of fog might be expected to continue until the intermingling masses of air had established a uniformity in temperature and direction of the air currents in any given locality.

Observations of fog observed off the coast of North America in the vicinity of the fortieth parallel show that its development closely follows the passage of low barometer areas, and continues during the presence of the succeeding areas of high barometer, or until the passage of the high areas has allowed the winds to assume their usual westerly direction.

In summing up the above conclusions, which are verified by a large number of special fog reports rendered by shipmasters, it will be seen that the conditions necessary to fog development in the region referred to are a steady and continued south to east flow of air from over the ocean, closely followed by a flow of cold, northerly winds from the land, by means of which the differences in temperature requisite to fog precipitation are occasioned. Fog predictions could, therefore, be safely based upon the movement of areas of low barometric pressure of pronounced strength which left the continent between the fortieth and forty-seventh parallels. These areas would indicate in their passage across the continent the probable strength and continuance of the south and east winds from over the ocean preceding their arrival, and the fall in temperature which would accompany their departure from the coast, and allow of calculating the differences in temperature which would exist in the opposing currents, and the consequent likelihood of fog. These calculations would be necessary to the successful making of fog predictions, and as they are already considered in the official predictions of the Signal Service for the Atlantic coast states, they could be readily extended to the adjoining ocean.

It will be seen by referring to the statements in this series of articles, that the conditions favorable for fog development would, as a rule, exist almost simultaneously over the Grand Banks and over the ocean south of Nova Scotia, and off the coast of the United States in the vicinity, and to the northward, of the fortieth parallel. In the first named locality its development, being dependent upon winds from the south and east quadrants of a storm-area, would slightly precede that of more western longitudes, where its origin would attend the southward flow of wind through the western quadrants of a low barometer area. It is therefore evident that westward bound steamships encountering fog, in its earlier development over the Banks, would, in a majority of instances wherein the cyclonic conditions were well defined, experience fog west of the sixtieth meridian.

PECULIARITIES OF FROST FORMATION.

The following communication upon this subject is from an observer of the Signal Service:.

ROSEBURG, OREGON, *June* 13, 1887.

The CHIEF SIGNAL OFFICER, U. S. A.,
Washington, D. C.

SIR: On page 91 of the MONTHLY WEATHER REVIEW for March, 1887, a report from the voluntary observer at Manatee, Fla., relative to "queer streaks in which frost is appearing," is given, together with an explanation by the editor of the REVIEW.

Upon this subject, I have the honor to report that Mr. Godfrey, a very reliable gentleman, who has a ranch on the west bank of the South Umpqua, three-quarters of a mile due southwest of this office, reports that on May 11, 1887 (I think the date a mistake, and that it was on May 12th), a peculiar frost occurred at his place among his potatoes and peas. The frost struck an occasional hill, a frost-bitten hill here, another there, and the same way throughout the two patches.

The frost did not confine itself to a single row, nor to a succession of hills in a single row, but it dotted the entire two patches. The potatoes are distant from the peas about one hundred and fifty yards due south, and an orchard separates them. The potatoes have the orchard on the north, some high weeds separate it from the river on the east, the south is unprotected, and the west is open ground, where a range of hills, five hundred feet high, protect the entire ranch from westerly winds. The potatoes are in a nearly level (no undulations) piece of ground, about fifty yards long and ten yards wide, extending in rows from east to west, with a slight rise of ground in almost the centre about two feet higher than at either end; the soil is sandy. Rains were frequent during the early part of May, and Mr. Godfrey is of the opinion that the surface was cultivated, during the rainy period of the first part of the month, previous to the frost. The moisture appeared to be evenly distributed. Trees protected the potatoes on the immediate north and bushes on the east. No relation seemed to exist between the frosted and unfrosted parts in relation to trees or bushes, as the frost dotted the entire patch. There does not appear to be any underground springs.

The peas are in rows, running north and south, about the same sized patch as that of the potatoes, all conditions the same, except that the soil surrounding the peas had not been cultivated at all, the orchard being in the south, the east some bushes, the north unprotected for one hundred yards or more, and on the west some thirty yards is his residence. The slope of the peas is from south to north; except the slight slope the ground is level, no undulations. The condition, quality, color, and constitution of the soil in both patches are the same.

I personally examined the field, and deduced the above from Mr. Godfrey's remarks and my own observation.

The occurrence was peculiar, and a solution of the problem would be interesting, inasmuch as the frost was so irregular in its action.

Very respectfully, your obedient servant,

B. S. PAGUE,
Corporal, Signal Corps.

SOIL TEMPERATURE AND MOISTURE.

By MILTON WHITNEY, Superintendent of the North Carolina Agricultural Experimental Station, Raleigh.

(Reprinted from "The Bulletin of the North Carolina Department of Agriculture.")

Our work, commenced last year, on the temperature and moisture of the soil, still gives promise of yielding interesting and valuable results. We believe we will be able to establish an important relation between these factors of plant growth and cotton production that may prove of considerable practical value to agriculture. Before publishing the results in detail we wish to collect more data and make further observations on the cotton soils. A comparison of the results obtained in our cotton field last year, in June, and for the same period this year, will be of interest, especially if studied in connection with the monthly report of the condition of the crops as compiled by the department, and the weekly "Weather-crop Bulletin" issued by the Chief Signal Officer from Washington. These weekly bulletins state briefly the general condition of the weather, with its departure from the normal as regards temperature and rainfall, and also whether it has been generally favorable for the crops, the latter information being gathered mostly from a large number of farmers throughout the country, who send in special weekly reports.

After a long time at such work it is probable that they will be able to tell by glancing at their temperature and rainfall data whether the weather has been favorable for certain crops at certain periods of time. But this can hardly be done now. For instance, it would be hard to tell by looking over their meteorological data now which had been the most favorable year in the past fifteen years for a large crop production. They will need to collect other data before they will be of the greatest benefit to the farmers and agriculture.

Six inches of rainfall a month, with a certain temperature, may mean a good season, or if the rain all came at once, followed by a succession of bright days, it might mean serious harm to the crops. In a green-house the amount of water given to a plant depends upon the temperature and upon the general appearance of the soil and plant. Every farmer can tell at a glance whether the weather is favorable for his crops, and whether his soil needs rain, without looking at the table of rainfall and temperature published by the Signal Service. His meteorological instruments will probably be his foot, with which he will knock the soil away and tell you that for such hot weather the soil is too dry for the growth of plants unless it is in the fall and the crops are ripening, when they will wish a dry soil, as a wet one will cause the crops to keep on growing, or "run to weed." Generally the farmers want plenty of moisture in the soil until the middle of July. Their crop production is not directly limited by the amount of rainfall, but by the moisture in the soil. The oasis in the desert owes its luxuriant growth of vegetation to the springs that come near the surface, as there is seldom or never rain.

Boussingault states that in one town in South America the inhabitants assured him they had had no rain in seventeen years. So, while we admit it is very important to know the rainfall, still, as the rain does not do the farmer any good until it enters the soil, it is very essential that the rainfall be studied below, as well as above, the surface of the ground.

On the study of the rainfall below the ground.

We found last year, in July, that we had fine growing weather for cotton when the soil contained 8 or 9 per cent. of moisture in the "fine earth," or about 170,000 to 290,000 pounds of water per acre in the top six inches. With this, and rather high temperature, cotton grew rapidly. It may be stated generally that, with a high temperature, the more moisture a soil contains within reasonable limits, the more favorable are the conditions for the production of "weed," while, with less moisture, the conditions are more favorable for the production of fruit. It must be remembered, however, that for good fruit production it is necessary to have well-developed plants, or sufficient "weed," and so the conditions favoring a good cotton crop will probably consist of a period favoring the production of "weed" for the perfect development of the

plant, with later a dry soil, favoring the production and early ripening of the fruit.

It is interesting, then, to compare the conditions of plant growth that existed last year with those of this year for the same period of time. When the soil temperature curves are used this comparison can be seen at a glance, but curves cannot well be reproduced in the "Bulletin."† Part of the data is given in the following table:

Week ending—	Mean temperature of the air and soil.					Pounds per acre of moisture in the soil.				Rain.		Condition of surface soil where sampled.
	Air.	3 inches.	6 inches.	12 inches.	24 inches.	6 inches.	12 inches.	18 inches.	24 inches.	Inches.	Pounds per acre.	
1886.												
June 4	71.5	74.0	72.2	70.6	67.3	323,263	328,779	411,446	423,232	1.2	271,152	Rained just before taking sample.
11	72.8	74.3	72.9	71.5	68.6	322,761	311,504	393,356	441,151	1.6	361,536	Too wet to work.
18	76.6	77.1	75.6	74.3	71.0	266,552	346,426	353,197	406,421	0.9	203,364	Very wet.
25	72.5	73.3	72.6	71.5	70.1	233,004	309,328	297,125	375,147	0.8	180,768	Fair condition.
July 2	72.9	74.1	73.4	72.9	71.3	437,109	393,177	390,752	486,448	2.45	553,602	Soil saturated.
1887.												
June 4	69.8	71.8	70.7	69.2	66.9	304,825	353,337	359,094	447,186	1.79	404,468	Very wet.
11	75.1	76.3	75.4	73.8	70.5	300,634	305,801	338,997	470,762	1.83	413,506	Do.
18	73.7	76.3	75.4	73.8	70.7	236,234	266,114	380,107	468,412	0.0	.....	Good condition.
25	79.6	81.5	81.0	78.9	75.3	*	.....	.....	.....	3.25	734,370	Very wet.
July 2	74.6	76.7	75.5	74.5	72.9	205,486	272,943	333,750	427,190	0.0	.....	Fine growing weather.

NOTE.—One inch of water per acre weighs 225,960 pounds.

* The sample of soil for week ending July 25 was taken by mistake in part of the field with the clay subsoil twenty-two inches below the surface, so the results are not comparable with the others.

† A diagram, showing the curves here referred to, was furnished by Mr. Whitney, and is represented in this number of the MONTHLY WEATHER REVIEW as chart V, *q. v.*—C. S. O.

The figures for the moisture in the soil for last year are not exactly the same as given in the annual report, as they have been recalculated on a new basis. The average weight of our sampler full of soil was found for twenty samples, each, representing the 1st, 2d, 3d, and 4th six inches in depth of soil (two feet deep in all). Stones larger than one-fifth of an inch were sifted out, and from the remainder the weight per acre of air dry "fine earth" was calculated. These weights for the different layers of our soil (a sandy loam, with clay subsoil, beginning eight inches below surface) are as follows: Top six inches, 1,809,084 pounds per acre; second six inches, 2,051,956 pounds per acre; third six inches, 2,033,273 pounds per acre; fourth six inches, 1,880,699 pounds per acre.

After taking a sample of soil, the per cent. of moisture in the "fine earth" is determined and calculated in pounds per acre on the above basis. The soil is under cultivation (in cotton), hence the comparatively small weight of surface soil per acre.

Conditions in 1887 *compared with* 1886.

Week ending—	Temperature of soil.	Moisture in surface soil.	Rain.
June 4	Lower.	Less.	More.
June 11	Higher.	Less.	More.
June 18	Lower.	Less.	Less.
June 25	Higher.	.....	More.
July 2	Higher.	Less.	Less.

It will be remembered June, 1886, was considered an unusually wet month. There was recorded 4.8 inches of rainfall against 6.22 inches this year. Yet we have found less moisture in the soil this year than for the corresponding periods of last year, save for one period which could not be compared. This will help to illustrate our position in regard to the insufficiency of the data furnished only by the rainfall and air temperature records of the Signal Service.

Our records are confessedly incomplete. The moisture is simply what is found in the soil at the end of a period of seven days, and does not represent the mean amount in the soil, so the results will depend largely upon the distribution of the rainfall. Still, until our methods can be improved, the data we are collecting are of value. Why is it that with 1.42 inches more rainfall this June than last, the month has not been so "wet" this year as last? Our other records show that there has been much more sunshine, or 71.3 per cent. of possible sunshine in June, 1887, against 47.92 per cent. for the same period in 1886. The difference of 23.38 per cent. (almost half as much as was recorded last year) must represent a great deal of evaporating power from the sun. Besides this, we find the mean temperature of the soil notably higher for June, 1887, than for 1886, and this would show conditions favorable for evaporation, and probably, in this case, more favorable for plant growth.